Genitourinary Trauma in Iraq and Afghanistan

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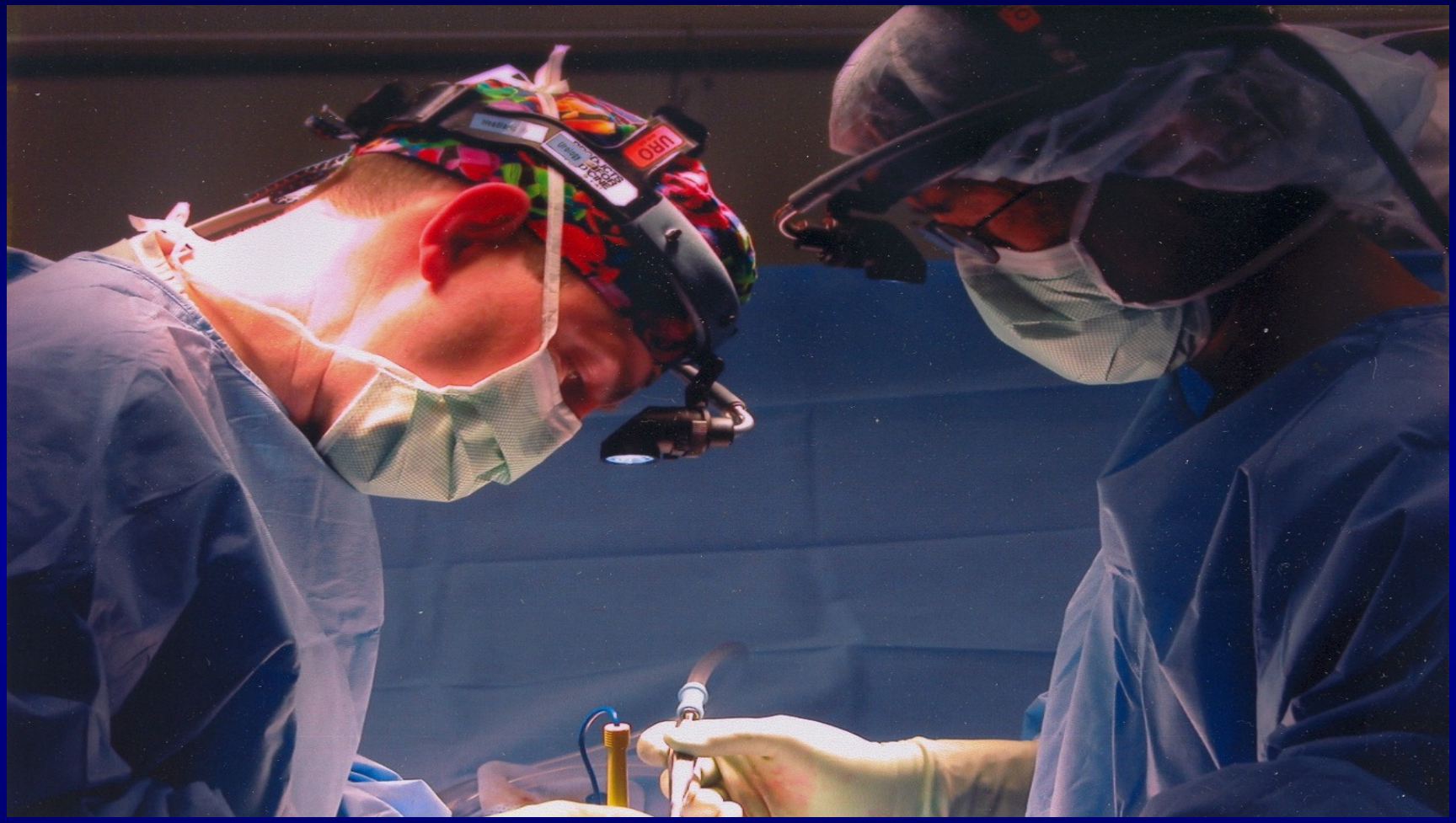


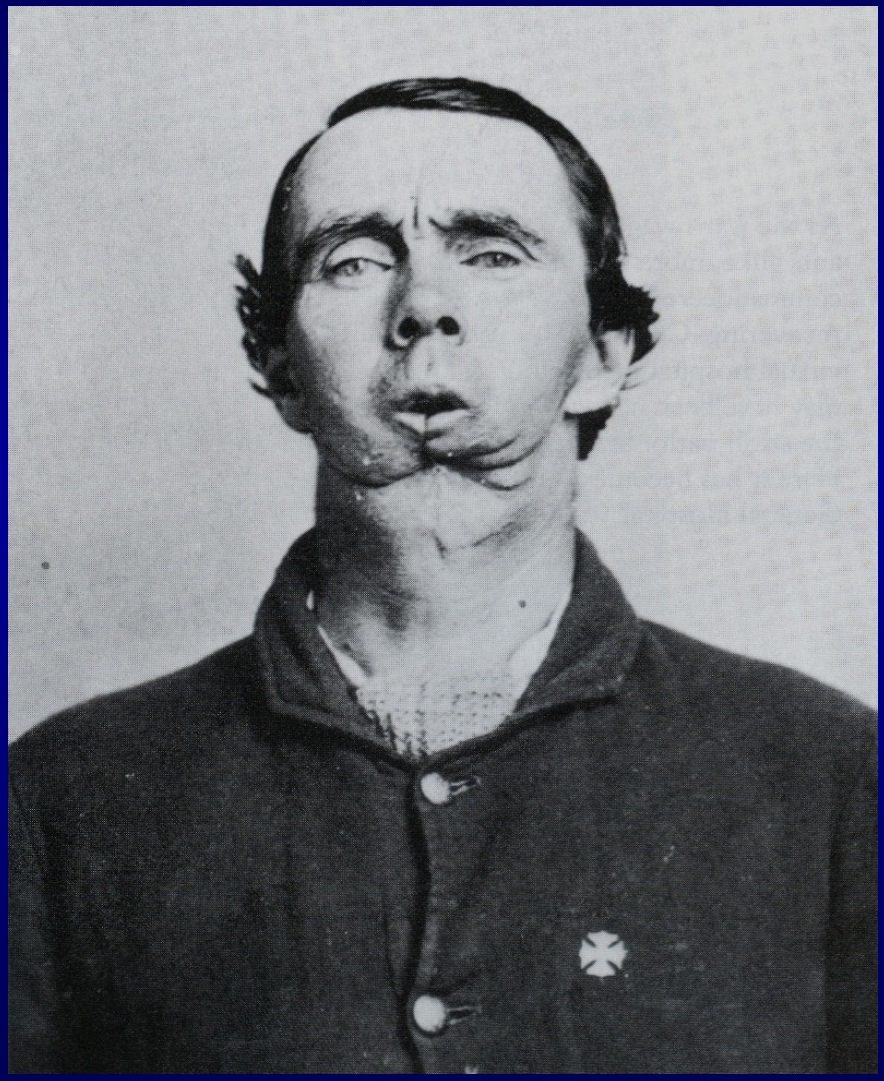
"...he who would become a surgeon, therefore, should join the army and follow it." *Hippocrates*

Aquellos que no han aprendido las lecciones de la historia están condenados a repetirlas

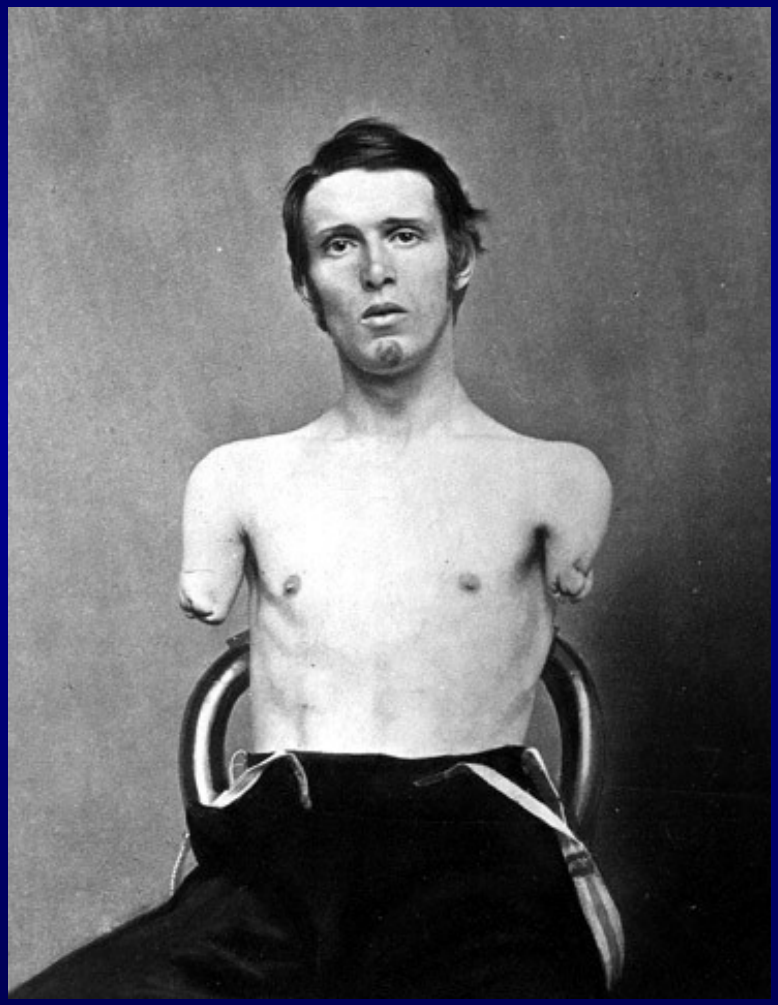
American Civil War
1861-1865

Civil War Casualties

	USA (North)	**CSA (South)**	**Total**
Died in Battle	110,100	94,000	204,100
Died from Diseases	224,580	164,000	388,580
Died in Prison	30,192	31,000	61,192
Total Deaths	653,872		
Wounded	281,881	194,026	475,907



Amputations and Prostheses



- General Barnum
  - Pelvic gunshot wound
    - Deemed “unsurvivable”
  - Civilian Surgeon
    - Punctured and Drained Abscess
    - Passed Drain Through Wound
  - Patient Maintained Drain
  - Died at age 85 years

Civil War - Improvements

- Battlefield Ambulances
- Evacuation of Wounded

Battlefield Hospitals

Hospital Ships

USNS *Red Rover*

USNS *Mercy*

First World War
1914-1917

- Mortality of Abdominal Wounds – 66.8%
- Frequency of Renal Wounds – 6.3%
- Surgery only for less severe abdominal wounds!

Urology in the Viet Nam War, Wettlauer & Weigel, Borden Institute, 2005, p. 40

First World War
1914-1918

- Muertos
  - England and Allies: 5,142,631 persons
  - Germany and Allies: 3,386,200 “
  - Total: 8, 528, 831 “
  - U.S. (1917-1918): 116.516 “
- Wounded
  - England and Allies: 12.800.706 personas
  - Germany and Allies: 8.388.448 “
  - Total: 21.189.154 “
  - U.S.: 204.002 “

Casualties in Major Wars; The Department of Justice; The National Archives;

First World War
1914-1917

- Mortality of Abdominal Wounds – 66.8%
- Frequency of Renal Wounds – 6.3%

- Surgical intervention only for *minor* abdominal trauma.

Urology in the Viet Nam War, Wettlauer & Weigel, Borden Institute, 2005, p. 40

Second World War
1941-1945

- Deaths
  - U.S. 418, 500 persons
- Injuries
  - U.S. 671, 846 persons

World War 2 Casualties; http://www.world-war-2.info/casualties

Second World War 1941-1945

- Mortality
  - 12% in single organ injury
  - 88% in multiple organ injuries

- Mortality of Surgical Patients
  - 7% if surgery within 8 hours of injury
  - 23% if surgery after 48 hours
  - 30 % overall mortality (equivalent to Civil War)

Urology in the Viet Nam War, Wettlauer & Weigel, Borden Institute, 2005, p. 40

Second World War 1941-1945

- Renal Injuries 13.4%
- Bladder Injuries 4.9%
- Ureteral Injuries 0.8%

- Mortality
  - Intra-abdominal Injuries 25.5%
  - Renal Injuries 30-35%
  - Bladder Injuries 30%

Urology in the Viet Nam War, Wettlauer & Weigel, Borden Institute,

Korean Conflict
1951-1953

- Deaths
  - U.S. 54,246 persons
- Injuries
  - U.S. 103,284 persons

World War 2 Casualties; http://www.world-war-2.info/casualties

Korean Conflict 1951-1953

- Mortality
  - Intra-abdominal wounds – 12%
  - Thoracoabdominal wounds – 10.3%
  - Renal injuries – 25.4%
  - Bladder injuries – 9.4%

Urology in the Viet Nam War, Wettlauer & Weigel, Borden Institute, 2005, p. 40

Viet Nam
1965-1973

- Deaths 58.193 persons
- Wounded 304,000 persons

- Average Age: 23.1 years
- Ethnicity
  - 86% Caucasian
  - 12.5% African American
  - 1.2% Other

Statistical Information About Casualties of the Viet Nam War; The National Archives; www.achives.gov/research/vietnam-war/casualty-

Viet Nam
1965-1973

Evacuation

- MEDEVAC helicopters – 500.000 missions
- 900,000 patients transported (1/2 U.S. population)
- Arrival to Battalion Aid Station in 1-2 hours
- Transfer to Level III (Japan, Philippines) in 7-12 days
- Return to U.S. > 30 days

Statistics About the Viet Nam War; http://www.vhfcn.org/stat/html

Viet Nam
1965-1973

- RenalTrauma – 33% of all urologic battle injuries
- Penetrating Renal Injuries - 80 %
- Mortality – 7.5%
- Injuries requiring Nephrectomy: 51 - 84 %
  - Irreparable kidney
  - Uncontrolled hemorrhage
  - Multi-organ injuries

Viet Nam

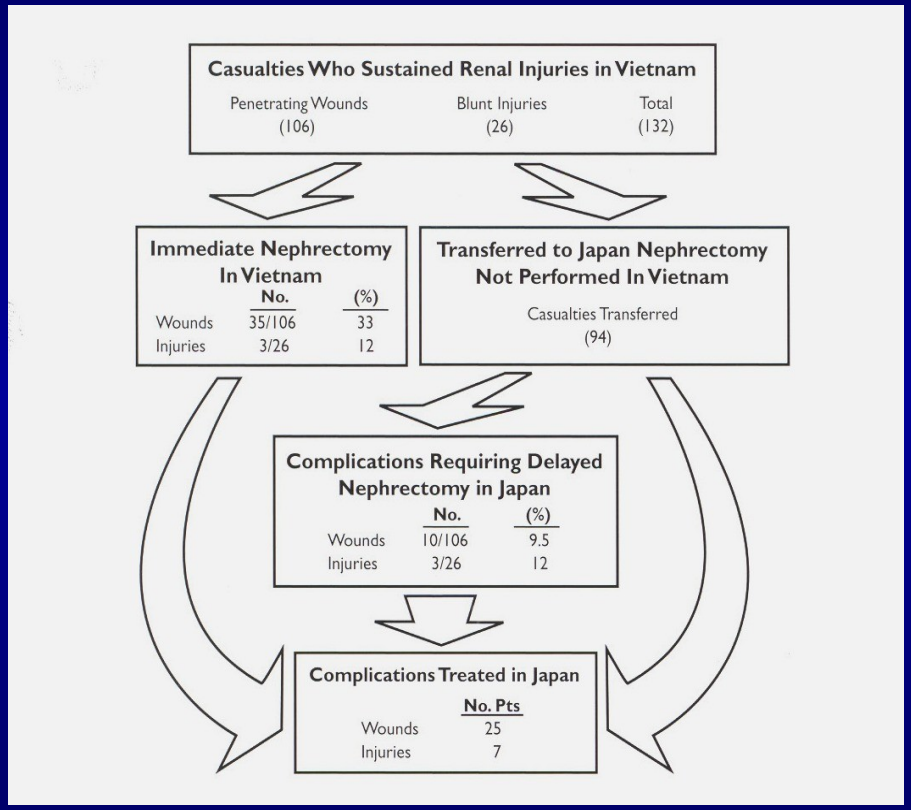


TABLE 2-1
GENITOURINARY TRACT INJURIES* FEBRUARY 1966–MARCH 1971

Injured GU Tract	Patients With Injured Organ		Injuries to GU Organs	
	No.†	%‡	No.	%
Scrotum-Testis	199	39.6	227	32.8
Kidney	132	26.2	132	19.1
Penis	128	25.4	128	18.5
Urethra	83	16.5	83	12.0
Bladder	72	14.3	72	10.4
Ureter	36	7.2	36	5.2
Spermatic Cord	14	2.8	14	2.0
Totals:			**692**	**100.0**

*In 503 patients seen by the authors during the Vietnam War at US Army Hospital, Camp Zama, Japan
†Some patients had injuries to more than one GU tract organ; the total number of patients (503) is less than the number of injuries
‡Number of patients with injured organ / 503 patients (x 100) = %
GU: genitourinary

Urology in the Viet Nam War, Wettlauer & Weigel, Borden Institute, 2005, p. 40

Viet Nam
1965-1973

- Ureteral Injuries
  - 5% of all urologic injuries
  - Mortality – 10.5 %
  - Can occur with penetrating or blunt abdominal trauma
  - 20% of ureteral injuries unrecognized
  - Complications
    - Urinary Fistulas
    - Abscess
    - Sepsis
    - Hydronephrosis, Obstruction
    - Urinary Acites

Viet Nam
1965-1973

- Bladder Injuries
  - 10-15 % of all urologic injuries
  - 9.7 % died in cases of abdominal injuries
    - Hemorrhage
    - Infection

Viet Nam
1965-1973

- External Genital Injuries
  - 2/3 of genitourinary injuries
  - Scrotal -Testicular > Penile > Ureteral
  - No change in incidence since Second World War

Improvements in Protection

Eye Protection- Before

Eyewear

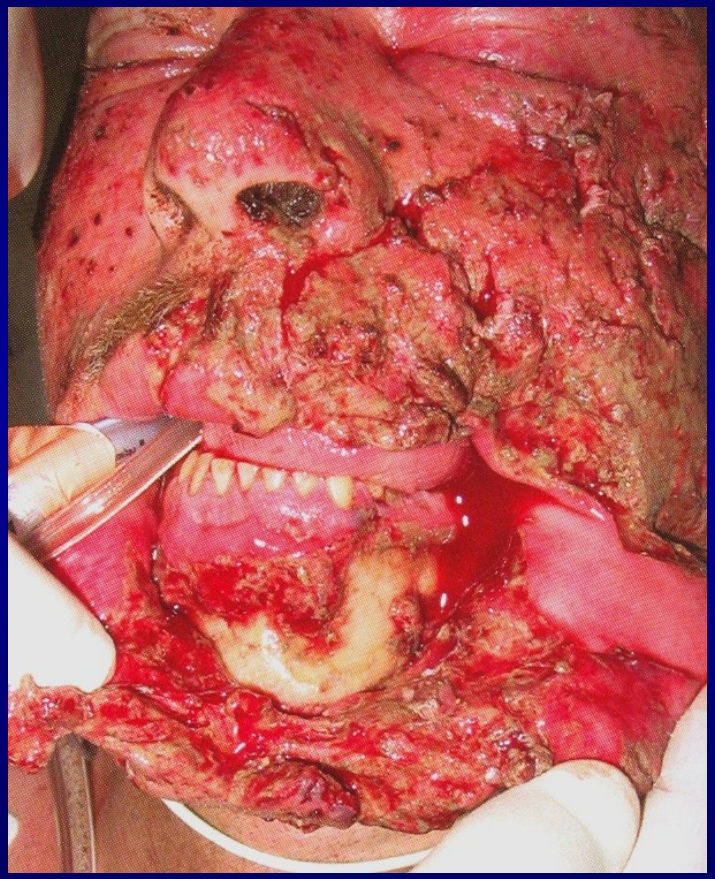
- “Birth Control Goggles”
- Gafas “Anticonceptivas”
- Not routinely worn due to aesthetics

Eye Protection - After

Results

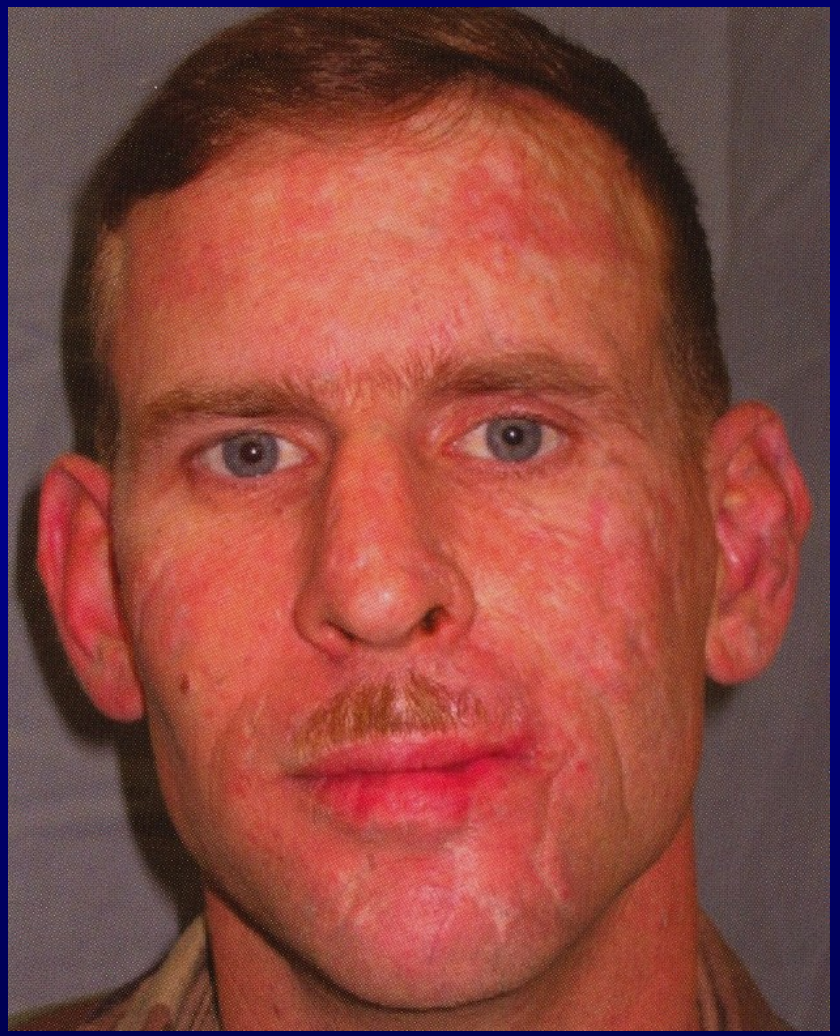
- More frequently worn
- Fewer Eye Injuries
- Preserved Vision
- Fewer surgical interventions

Facial Trauma from Explosion



Facial Trauma from Explosion

1 year later



BODY ARMOR

“The unprecedented use and effectiveness of today’s protective equipment (all other factors being equal) should make for a less lethal battlefield because armor decreases the lethality of weapons.”

Ronald Bellamy, M.D., COL USA (Ret)

Body Armor (Viet Nam – 1960’s)

Gear Revolution

- 73 items Typical
- Weapons
- Clothing
- Enhanced NVG’s
- Portable Solar Panel

Body Armor

Body Armor

Body Armor

Gentiourinary Trauma

- IED blasts
  - Presently the primary cause of U.S. battle casualties
  - 34,360 U.S. troops killed or wounded by IED’s
  - Includes Iraq and Afghanistan
  - Body Armor
    - Protects chest, abdomen, back
    - Leaves extremities, pelvis exposed
    - Upward blast of buried bombs

Gentiourinary Trauma

- Since 2005 - 1,500 genital wounds
  - 12 months prior to surge – 170 genital wounds

- Late 2009
  - “Surge'' of 30,000 troops into Afghanistan
  - Increased foot patrols
  - Pace of genital injuries has accelerated.
  - 2010 –259 genital injuries
  - 2011 – 299 cases

Protective Under Garment (PUG)

Tier 1

a Protective Under Garment (PUG) worn next to the skin which is designed to reduce penetrations of dirt and fine debris

Crye Precision Protective Under Garment
(Note – available in light and medium weight)

Cooneen, Watts & Stone (CWS) Protective Under Garment

K-L Manufacturing Protective Under Garment

Secure Planet Protective Under Garment with Internal Ballistic Panels in Groin and Femoral Regions

BCB Protective Under Garment

Shock Doctor Female Pelvic Protector
(Note – worn with jock strap or female jock shorts)

Shock Doctor Titan Alloy
(Note – worn with jock strap)

Shock Doctor protectors are worn in conjunction with Tier 1 PUGs.

Tier 2

a Protective Over Garment (POG) worn over the ACU Pant which is designed to reduce penetrations of fragmenting munitions and larger debris

Crye Precision Contoured Groin Wrap

Hawk Protection Groin Wrap

TIER I – Protective Inner Garment (PUG)

•

External seams for comfort
The kevlar portion shields the perineal area
Mesh helps keep wearer cool
Extended inner leg helps protect the femoral artery

TIER II – Protective Outer Garment (PUG)

-

Blast Injuries

1. Translational Blast Injury
2. Toxic Gases
3. Blast Overpressure
4. Missiles

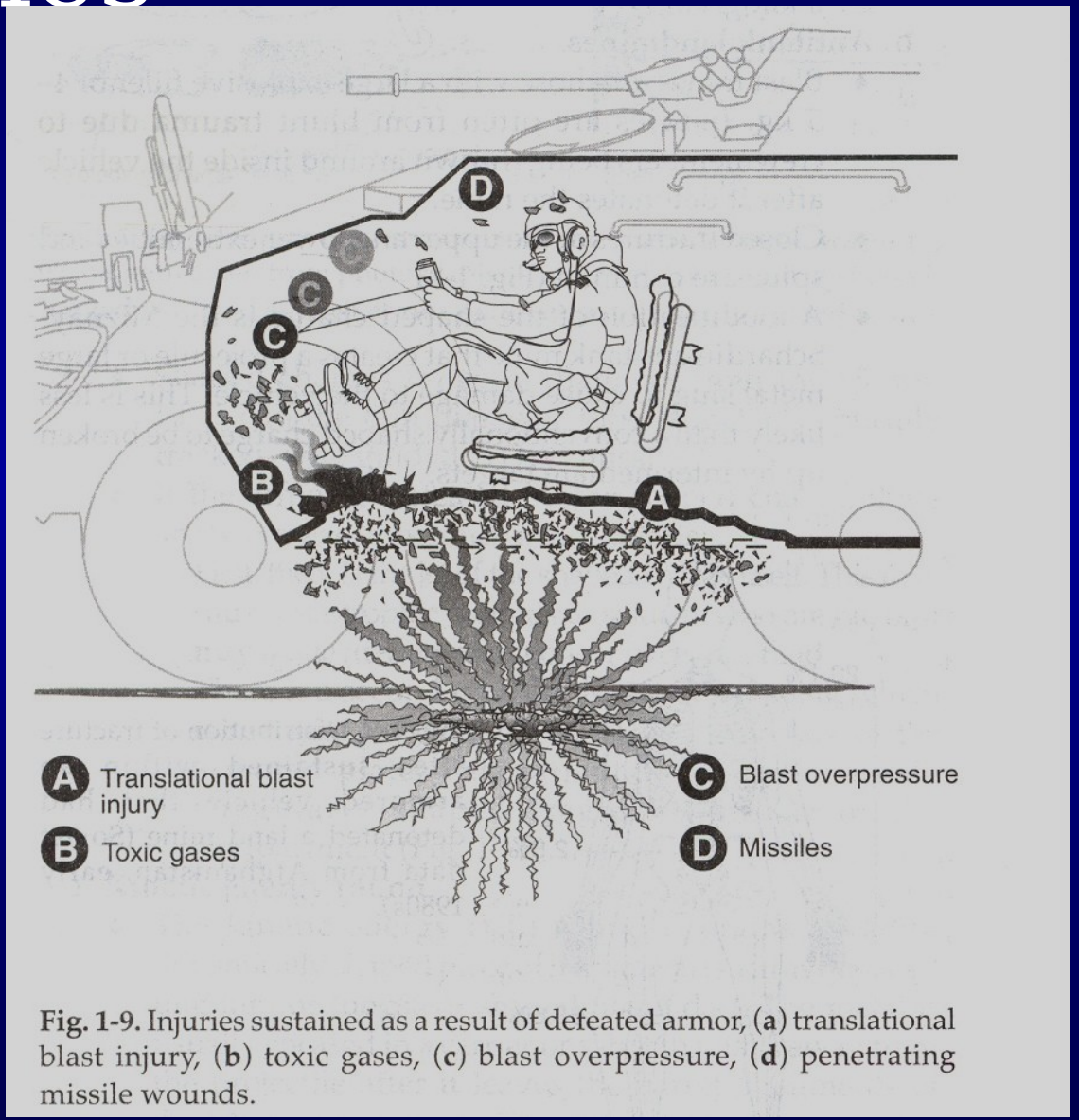


Fig. 1-9. Injuries sustained as a result of defeated armor, (**a**) translational blast injury, (**b**) toxic gases, (**c**) blast overpressure, (**d**) penetrating missile wounds.

Body Armor

Iraq:

Genitourinary Injuries With Body Armor: 2.1 %

Without Body Armor: 3.4%

(p = 0.034)

Deaths w/ Renal Injury with Body Armor: 0.5 %

Deaths w. Renal Injury without Body Armor: 1.4 %

(p = 0.017)

Explosion Injuries

1. Initial Injury by Explosion
2. Toxic Gases
3. Secondary Blast by increased pressure
4. Projectiles
5. Heat

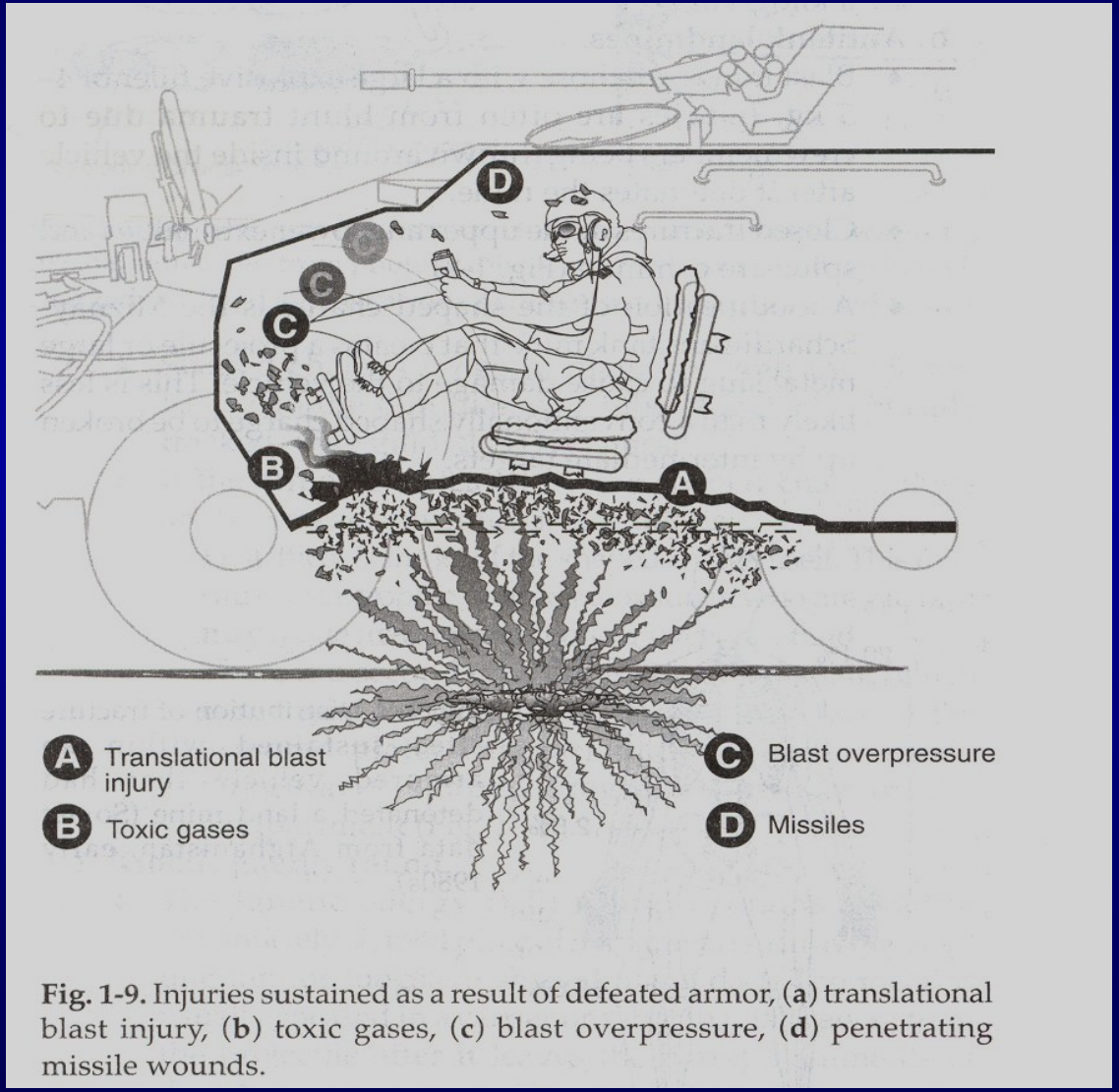


Fig. 1-9. Injuries sustained as a result of defeated armor, (**a**) translational blast injury, (**b**) toxic gases, (**c**) blast overpressure, (**d**) penetrating missile wounds.

Explosion Injuries

Anti-personnel Mines or IED's

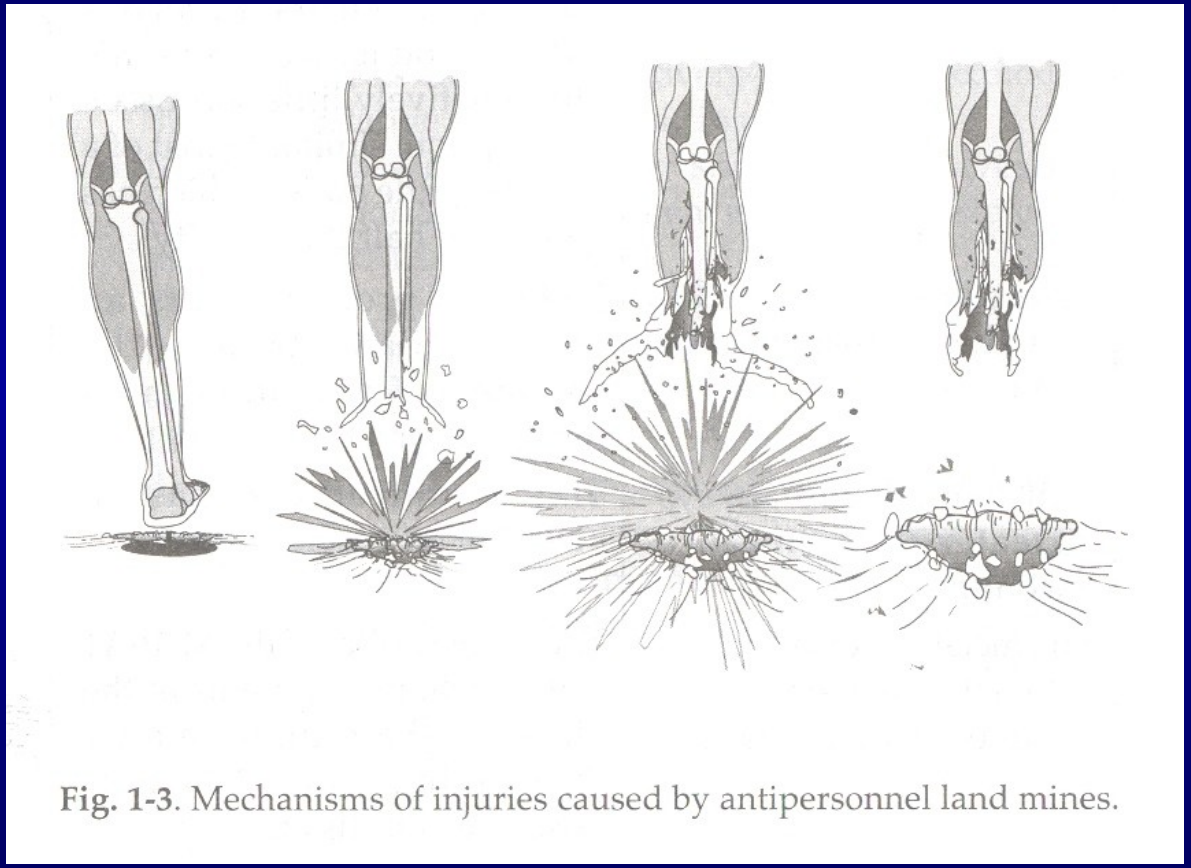


Fig. 1-3. Mechanisms of injuries caused by antipersonnel land mines.

War Surgery in Afghanistan & Iraq, Nessen, Loundsbury, Herz (eds.); Borden

Exploding Injuries

Cavitation Injuries from High Velocity Rifles

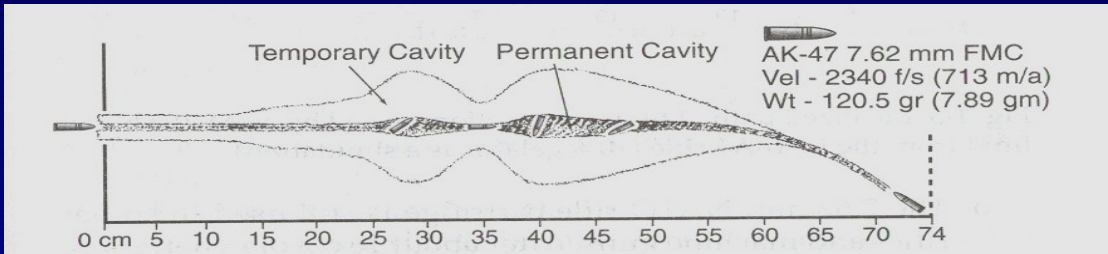

Temporary Cavity
Permanent Cavity
AK-47 7.62 mm FMC
Vel - 2340 f/s (713 m/a)
Wt - 120.5 gr (7.89 gm)
0 cm 5 10 15 20 25 30 35 40 45 50 55 60 65 70 74

Fig. 1-4. Idealized path of tissue disruption caused by an AK-47 projectile, (10% gelatin as a simulation).

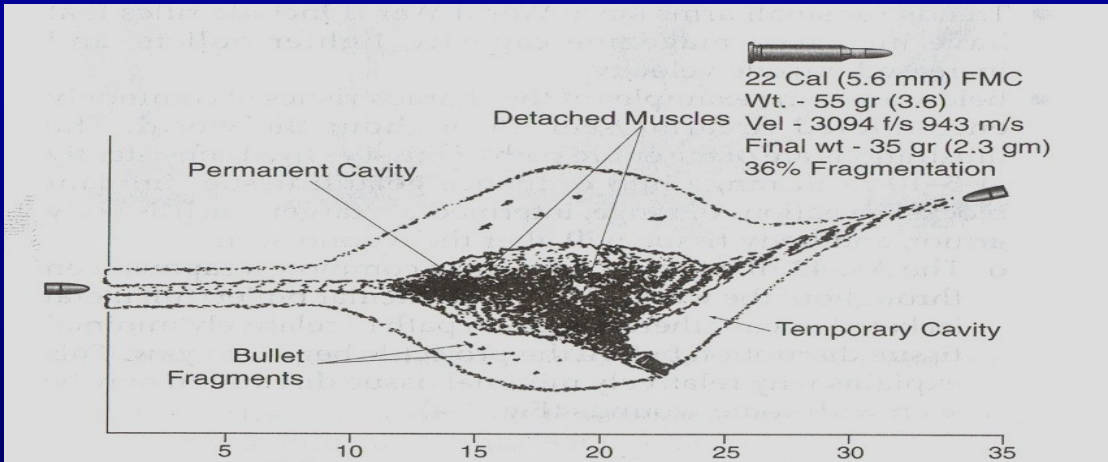

22 Cal (5.6 mm) FMC
Wt. - 55 gr (3.6)
Vel - 3094 f/s 943 m/s
Final wt - 35 gr (2.3 gm)
36% Fragmentation
Detached Muscles
Permanent Cavity
Temporary Cavity
Bullet Fragments
5 10 15 20 25 30 35

Fig. 1-5. Idealized path of tissue disruption caused by an M-193 bullet fired from the M-16A1 rifle (10% gelatin as a simulation).

War Surgery in Afghanistan & Iraq, Nessen, Loundsbury, Herz (eds.); Borden

Iraq and Afghanistan

Table 3-3. Anatomical Location of Injury.*

Anatomical Location	Frequency	Percent
Multiple Sites	761	49.7%
Lower Extremity	248	16.2%
Upper Extremity	223	14.6%
Head/Face	174	11.4%
Thorax/Back	48	3.1%
Neck	20	1.3%
None	20	1.3%
Abdomen	16	1.0%
Unknown	9	0.6%
Buttock	6	0.4%
N/A	3	0.2%
Genitalia	1	0.1%
Soft Tissue	1	0.1%
Total	1530	100%

* Casualties with more than one injury location are included in 'Multiple Sites'. These numbers are based on 1530 Level III casualties.

Table 3-1. Type of Injury.*

Type of Injury	Frequency	Percent
Penetrating	645	35.7%
Blast	425	23.5%
Blunt	410	22.7%
Unknown	84	4.6%
Crush	63	3.5%
Mechanical	49	2.7%
Thermal	48	2.7%
Undetermined	21	1.2%
Other	16	0.9%
Chemical agent	10	0.6%
Bites/Stings	8	0.4%
Degloving	8	0.4%
Electrical	7	0.4%
Heat Injury	7	0.4%
Inhalation	3	0.2%
Multiple Penetration System	3	0.2%
Total	1807	100%

* A casualty may have more than one type of injury. These numbers are based on 1530 Level III casualties.

War Surgery in Afghanistan & Iraq, Nessen, Loundsbury, Herz (eds.); Borden Inst. Press, 2008.

Iraq and Afghanistan

Table 3-2. Mechanism of Injury.*

Mechanism of Injury	Frequency	Percent
IED	310	18.4%
MVA	207	12.3%
Gun Shot Wound (GSW)	188	11.1%
Grenade (includes RPG)	170	10.1%
Shrapnel/Fragment	141	8.3%
Unknown	119	7.0%
Machinery or Equipment	95	5.6%
Fall or Jump from height	90	5.3%
Mortar	84	5.0%
Burn	53	3.1%
Aggravated Range of Motion	31	1.8%
Landmine	29	1.7%
Other	27	1.6%
Knife or other sharp object	21	1.2%
Helicopter Crash	19	1.1%
Blunt object (eg, rock or bottle)	17	1.0%
Pedestrian	16	0.9%
Free Falling Objects	14	0.8%
Bomb	12	0.7%
None	12	0.7%
UXO	10	0.6%
Environmental	9	0.5%
Exertion/overexertion	5	0.3%
Flying debris	5	0.3%
Building Collapse	2	0.1%
Hot Object/Substance	2	0.1%
Altercation, fight	1	0.1%
Total	**1689**	**100%**

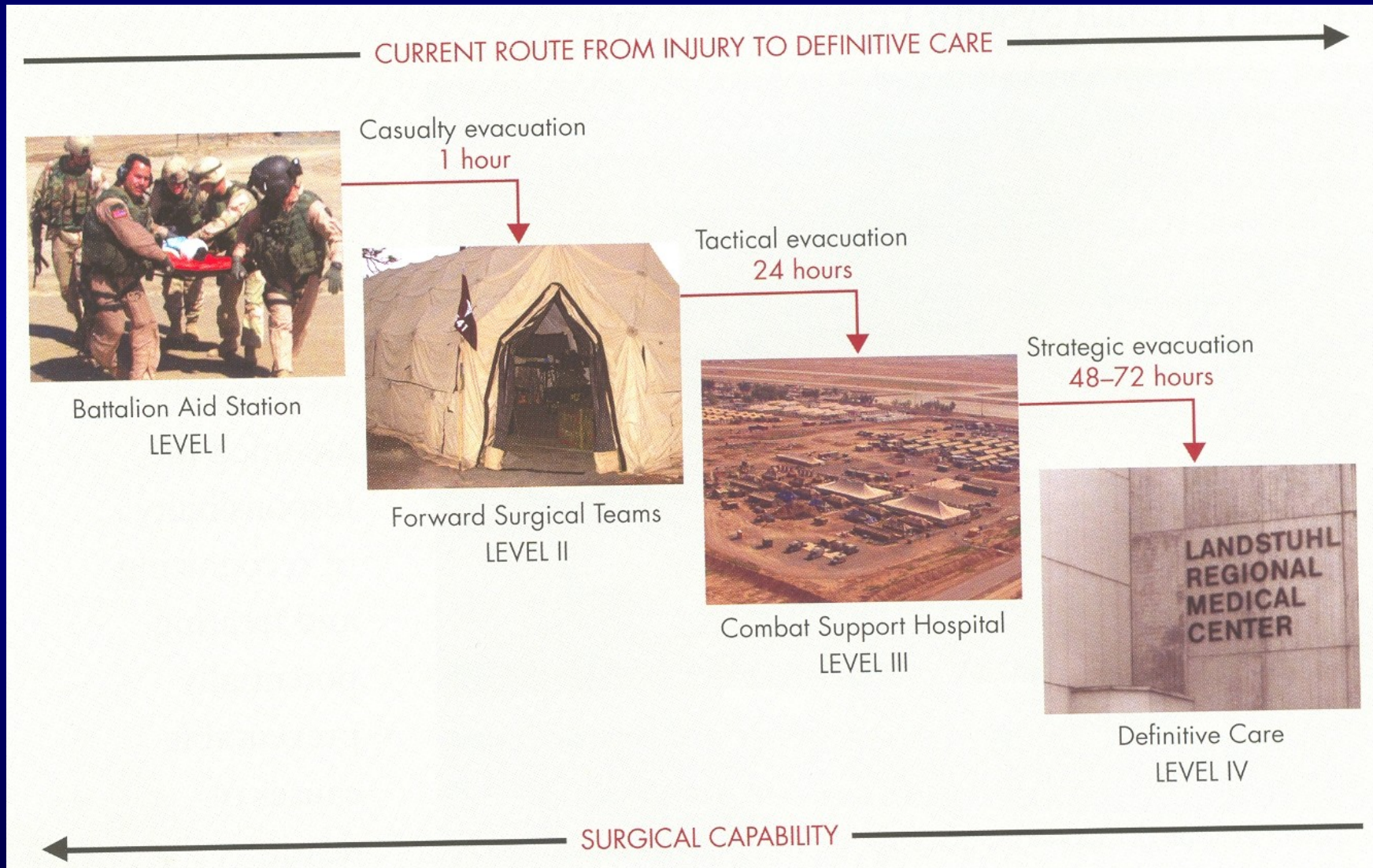
* A casualty may have more than one mechanism of injury. These numbers are based on 1530 Level III casualties.

War Surgery in Afghanistan & Iraq; Nessen, Loundsbury, Herz (eds.); Borden Inst. Press, 2008.

Medical Evacuation

- Second World War: Average of 16 hours from battlefield to hospital.
- Korea: Helicopter evacuation to Mobile Army Surgical Hospital(MASH) in 10 hours.
- Vietnam: Better use of helicopters improved arrival time to1-2 hours.

Medical Evacuation System



Case Presentations:

Genitourinary Trauma in Iraq and Afghanistan

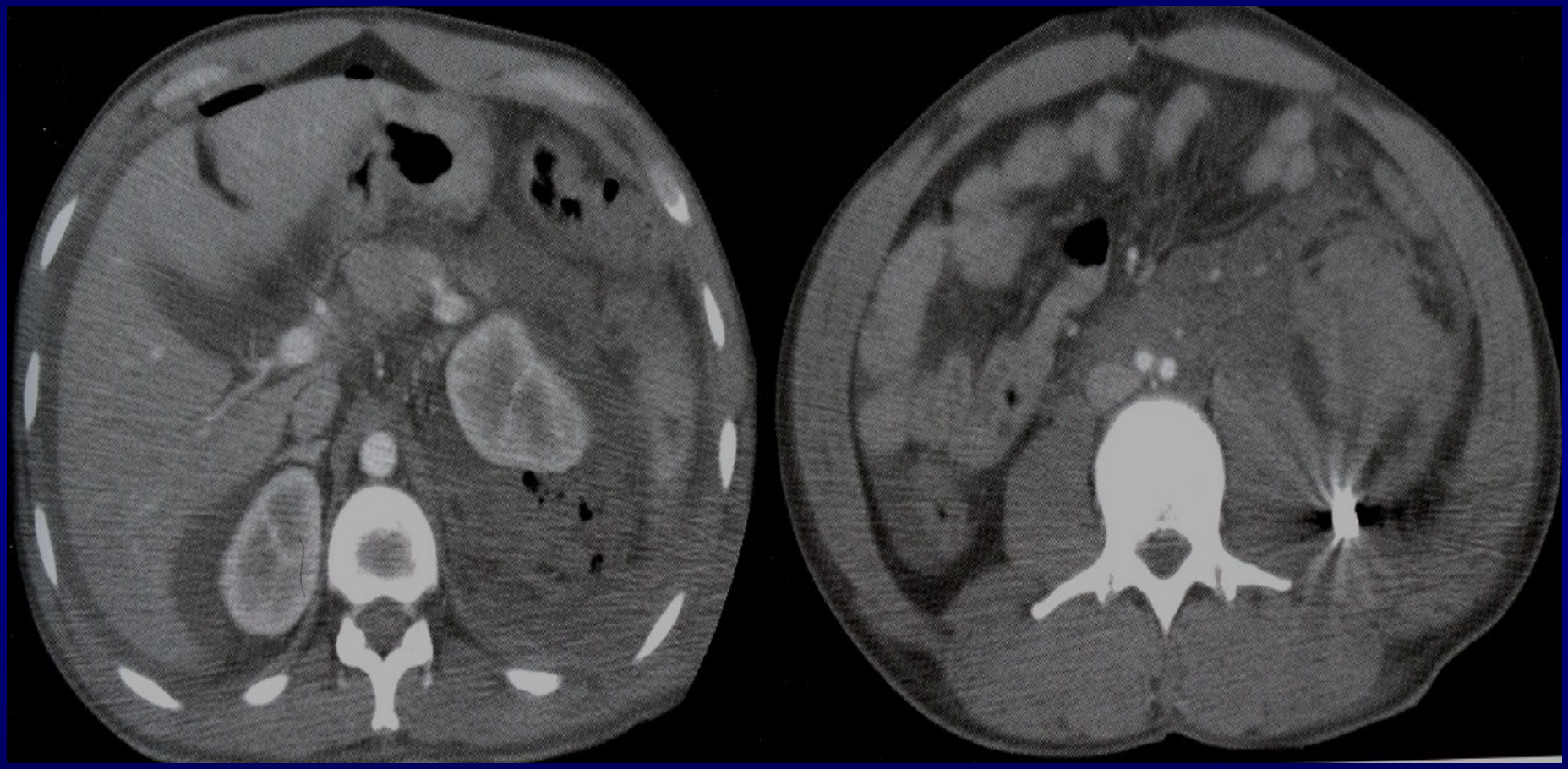
Case 1 – Renal Trauma

- Afghan male 23 years old
- Sniper Attack on-base
- Single Bullet
- Penetrating injury in posterior axillary line below 12th rib
- To O.R. immediately
- Transfused 2 units of blood
- Exploration – no obvious lesions

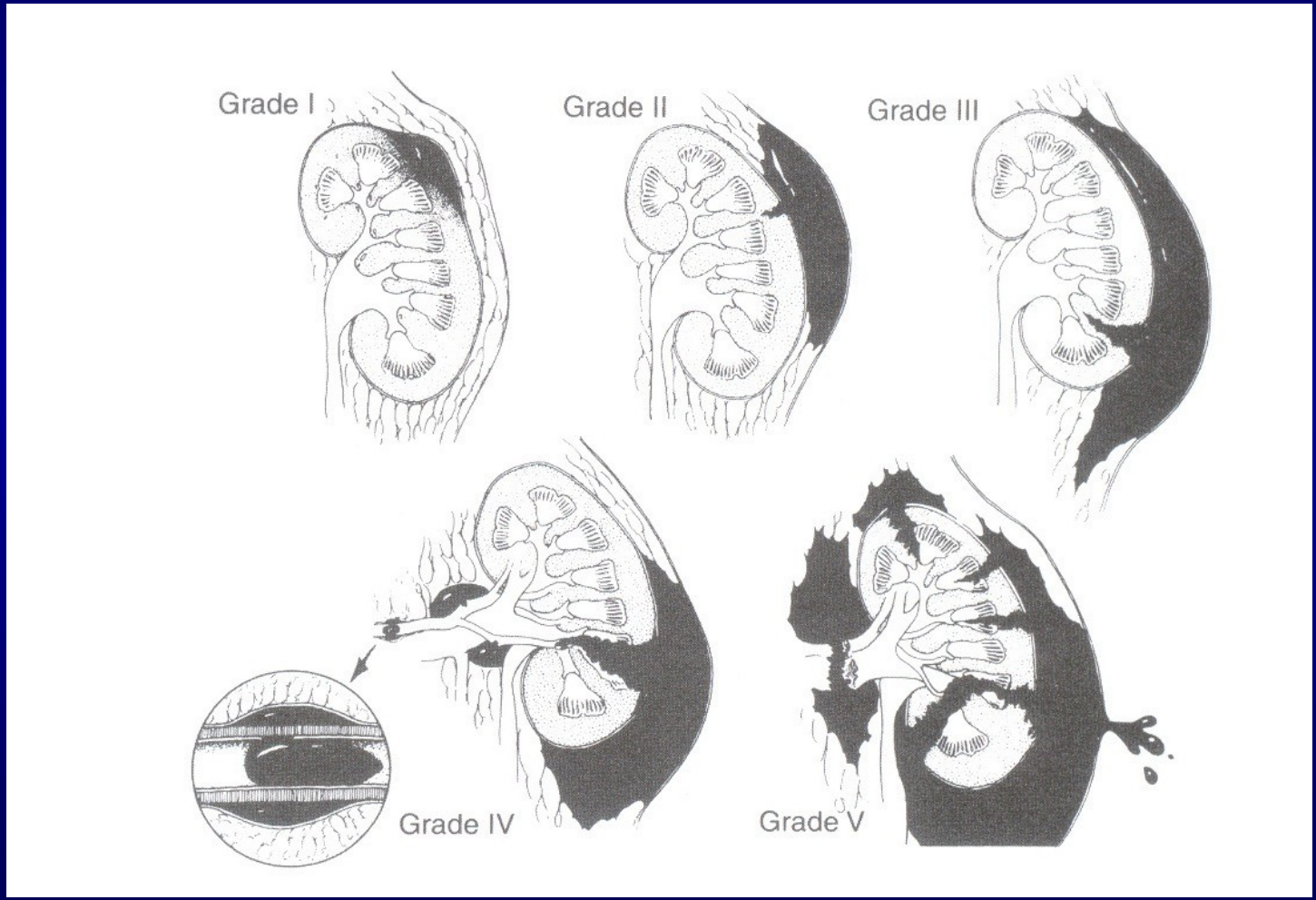
Case 1 – Renal Trauma

- Post-Injury Day 1
  - Unstable vital signs
  - BP: 80/50 mmHg; Pulse: 135 bpm.
  - Hemoglobin – 7 g/dL
  - INR – 3.1
- CT with contrast and delayed images
  - Grade 3 Left Renal Lesion
  - Intact Vasculature
  - No extravasation of contrast

CT



Grades of Renal Trauma



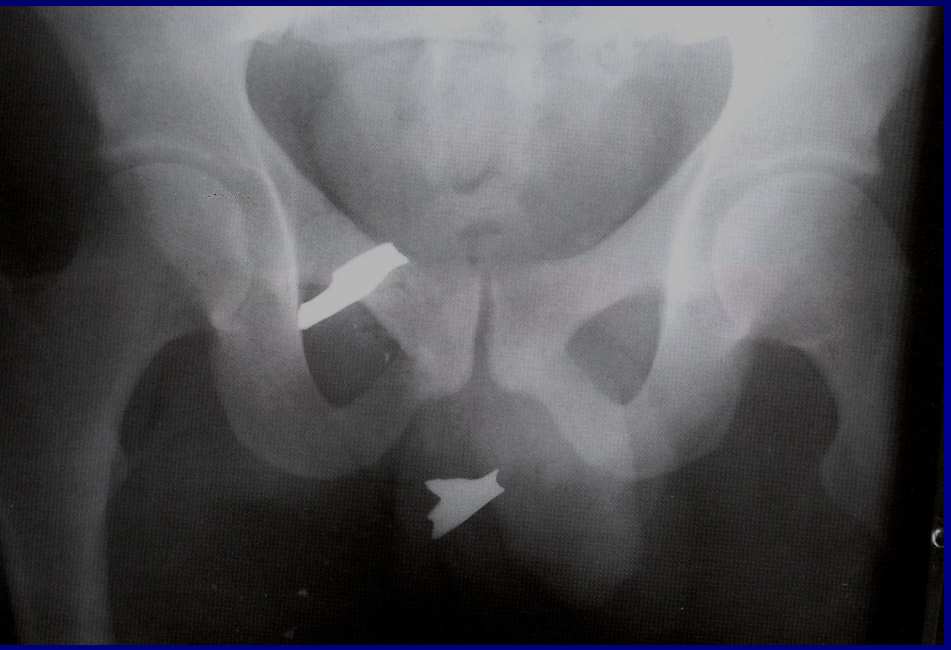
Case 1- Renal Trauma

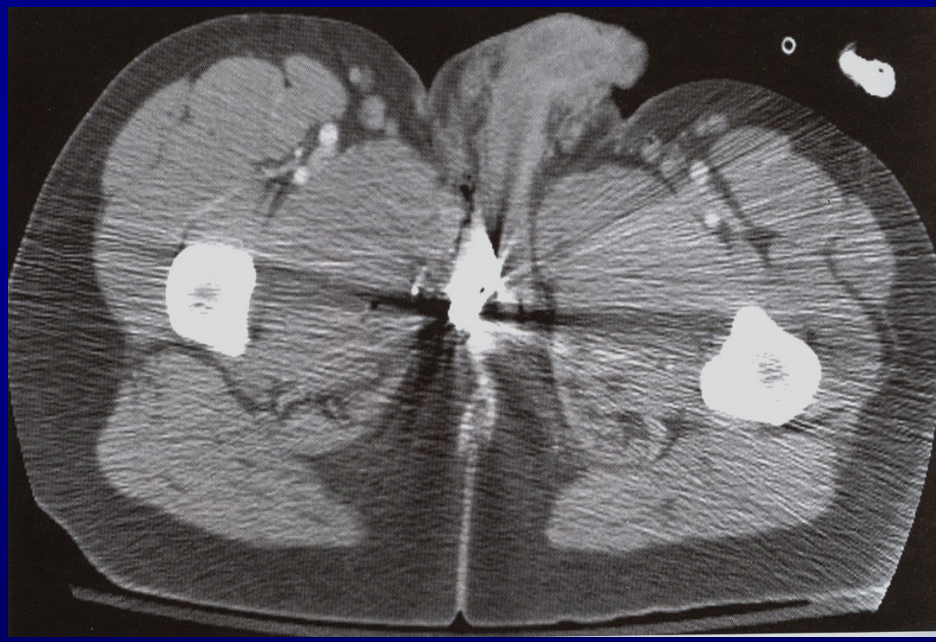
- Managed without surgical intervention
- Transfusion
  - 2 units more of PRBC’s
  - 4 units of plasma
  - 7.500 µg Factor VII
- IV fluids
- Discharged on Post-injury Day 5

Case 2 –Pelvic Trauma

- 27 year-old male
- Passenger in military vehicle
- IED Explosion
- Penetrating Injuries in the Posterior-superior zone of the right pelvic musculature (gluteus)

Radiographs





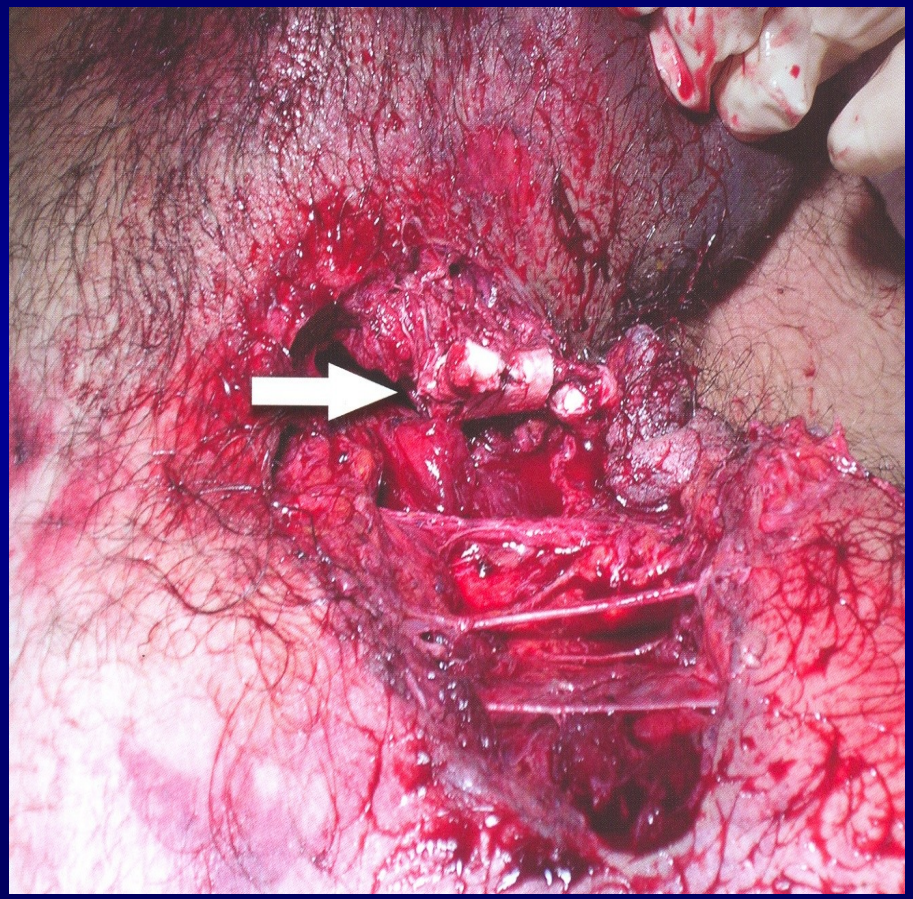
Case 2 – Pelvic Trauma

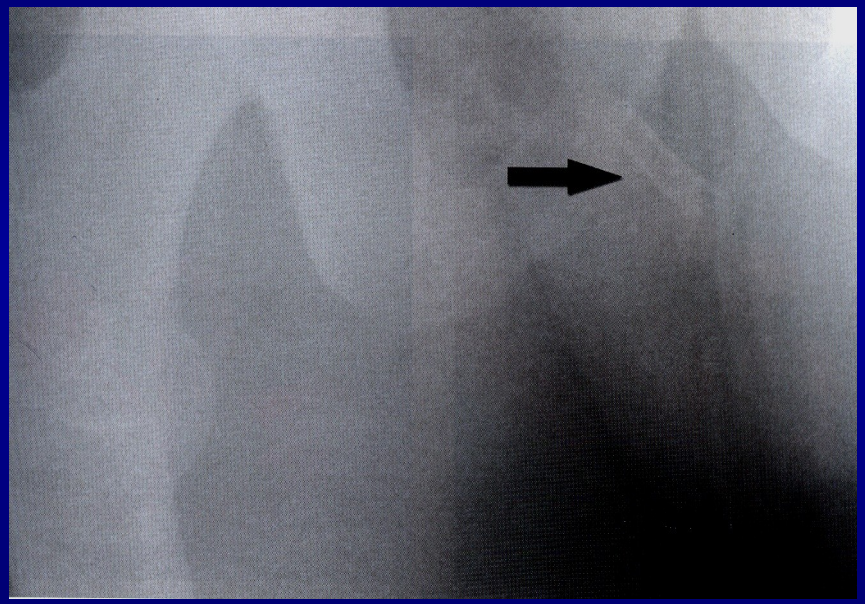
- To O.R.
- Proctoscopy negative for rectal injury
- Cystoscopy and Retrograde Urography of urethra, bladder, and ureters without injury
- Overnight observation
- Evacuated to higher level of care the following morning.

Case 3 – Scrotal Trauma

- Iraqi male, 23 years-old
- Suicide bomb victim
- Injuries to right inguinal area
- Diffuse edema and ecchymosis

Physical Exam and Radiographs





CT of Pelvis

- Abnormal Right Testicle
- Foreign Body posterior to right testicle

Case 3 - Operative Findings

Rib fragment extracted from right scrotum

(rib fragment from other victim)

Case 3 - Operative Findings

- Loss of Right Testicle (Avulsion Injury)
- Removed surgically
- Transferred to Higher Level of Care on Post-Injury Day 2

Case 4 – Penile Trauma

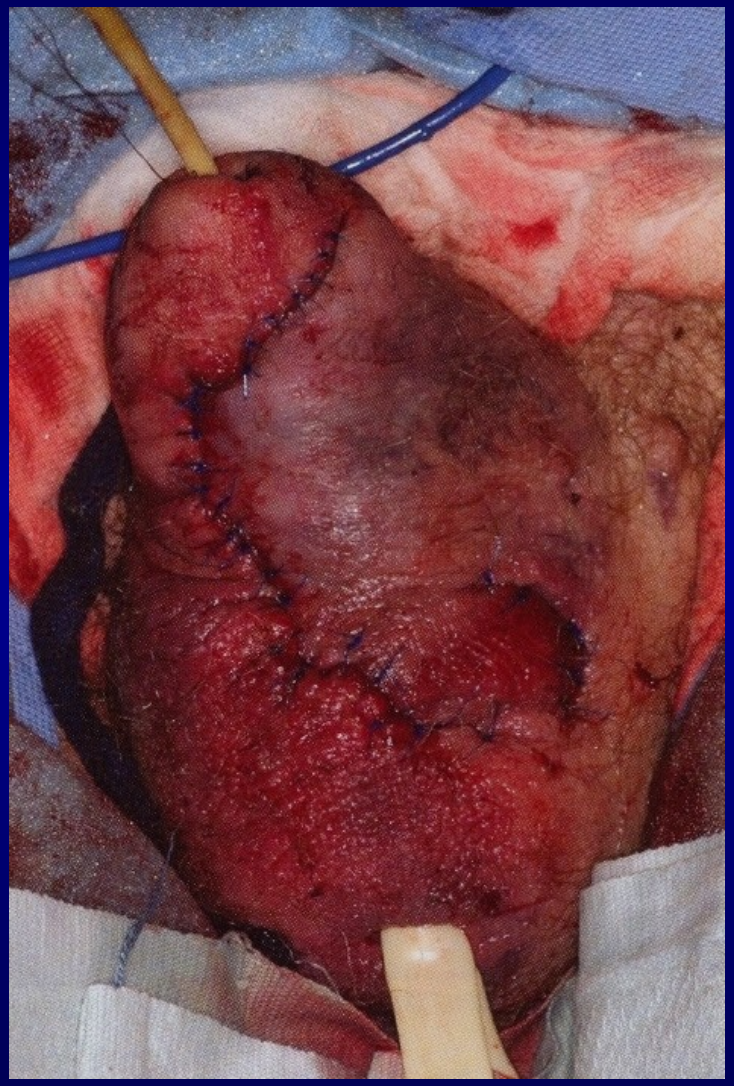
- 29 year-old soldier, passenger in military vehicle
- IED explosion
- Multiple injuries: face, right hand, lower extremities, penis, scrotum
- Surgically stabilized at Combat Support Hospital
- Transferred to Landstuhl (Germany) within 12 hours

Case 4 – Penile Trauma

- Surgical Debridement
- Basic Genital Reconstruction
  - Left Orchiectomy
  - Repair of Right Testicular Rupture

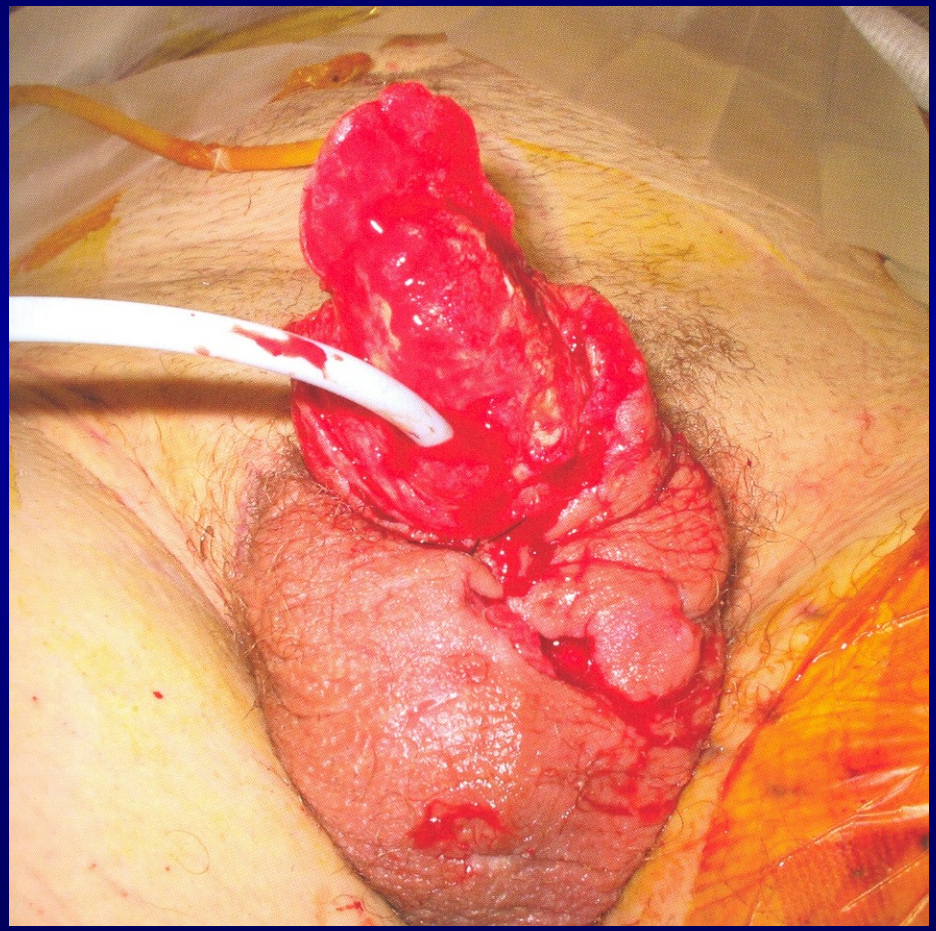
Case 4 – Penile Trauma

- Recontruction of Glans Penis
  - Urethral reconstruction with 12-French Catheter
- Transferred to Walter Reed Army Medical Center on Post-Injury Day 5.



Case 4 – Penile Trauma

- 2 weeks post-injury
  - Surgical debridement of non-viable tissue
  - Formal Penile Reconstruction



Case 4 – Penile Trauma

- Buccal Mucosal Onlay graft to repair urethra
- Skin graft for repair of shaft skin

Casos Milagrosos

Trauma With Severe Shock

- 23 year-old male soldier
- 2 meters from mortar explosion
- Poorly controlled bleeding
- Combat Hospital 2 kilometers away
- Multiple Serious Injuries
  - Abdomen
  - Lower Extremities
  - Right Hand

Massive Hemorrhage

Applying Direct Pressure on Femoral Arteries

Multi-Trauma with Shock

- Laparotomy with Colostomy
- Amputation of Right Hand
- Mid-femur Amputation of Right Lower Extremity
- Below Knee amputation of Left Lower Extremity

- To ICU
- Transferred to Landstuhl (Germany) in less than 12 hours
- Transferred to U.S. (Walter Reed) 36 hours after initial presentation.

- Multiple Injuries due to explosion
- In earlier wars, this was non-survivable injury

Post-operative

Rehabilition

Gentiourinary Trauma – The Future

“ So the Lord God caused the man to fall into a deep sleep, and while he was asleep, He took part of the man’s rib, and closed up the place with flesh. Then The Lord God made a woman from the part He had taken out of the man, and He brought her to him”

Genesis 2:21

Genitourinary Trauma – The Future

- 4 Medical “First’s” Described in this passage.
  - Anesthesia
  - Surgery
  - Cloning
  - Tissue Engineering

- Not described in any other ancient text

- Charles Lindberg and Alex Carrel (1935)
  - First to investigate keeping organs alive *ex vivo*

Genitourinary Trauma – The Future

- First organ transplant
  - Kidney (Guild, 1955)
- 1970's
  - Cell Biology and Material Sciences combine forces
  - Tissue Engineering
- 1981
  - Pluripotent Stem Cells in Embryos
- 1999
  - William Haseltine (Human Genome Sciences)
  - "Regenerative Medicine"

Genitourinary Trauma – The Future

- 2002
  - Adult stem cells
    - Bone Marrow
    - GI tract
    - Skin
    - Brain
    - Muscle
  - Area of intense focus, new research

Genitourinary Trauma – The Future

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Genitourinary Trauma – The Future

- Wake Forest Institute for Regenerative Medicine:
  - Regenerated bladder tissue
  - Cells grown on scaffold
    - Collagen
    - Silicone
    - Alginate

Genitourinary Trauma – The Future

- Wake Forest Institute for Regenerative Medicine:
  - Encapsulated Leydig Cells
  - Produce Testosterone
  - Implanted in hypogonad animals
  - Testosterone production documented

Genitourinary Trauma – The Future

- Wake Forest Institute for Regenerative Medicine:
  - Regenerated penises of 12 New Zealand White Rabbits
  - All survived reconstructive surgery
  - Copulated with females
  - Four (4) females impregnated

Genitourinary Trauma – The Future

- Ureteral Tissue
- Urethral Tissue
- Vaginal/Uterine/Ovarian Tissue
- Renal Tissue
  - Complex filter
  - Acid Base Balance
  - Fluid Regulation
  - Erythropoietin Production

Gentiourinary Trauma

- Uro-Trauma Bill, H.R. 1612 - April 15, 2011
- Increased battlefield rescues & GU injuries
- Increased need for:
    - Research & Development
    - Coordination of Resources (DOD/VA/Civilian)
    - Resource registry – “Pool of Talent”
    - Patient Registry – Outcomes research
    - Education
        - Best Practice Patterns
        - Resource availability

Uro-Trauma H.R. 1612

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¡Gracías por su atencíon!

¿Preguntas?